

The Maths inside Computers

Michael Spivey

Tutor, Oriel College



UNIVERSITY OF
OXFORD

Department of
COMPUTER
SCIENCE

Copyright © 2013–20 J. M. Spivey

Writing down the rules

1. Start with the two numbers to be multiplied in columns x and y , and 0 in column z .
2. Repeat until 0 appears in column x :
 - if x is odd, replace z by $y + z$.
 - replace x by $x \div 2$ and y by $2 \times y$.
3. The answer appears in column z .

Writing it as a computer program

$x := a; y := b; z := 0;$

while $x \neq 0$ **do**

if $ODD(x)$ **then** $z := y + z$ **end;**

$x := x \div 2; y := 2 \times y$

end;

return z

Hang on a minute!

Why not just use this program:

return $a \times b$

and have the multiplication done by an electronic circuit in the computer?

Hang on a minute!

Why not just use this

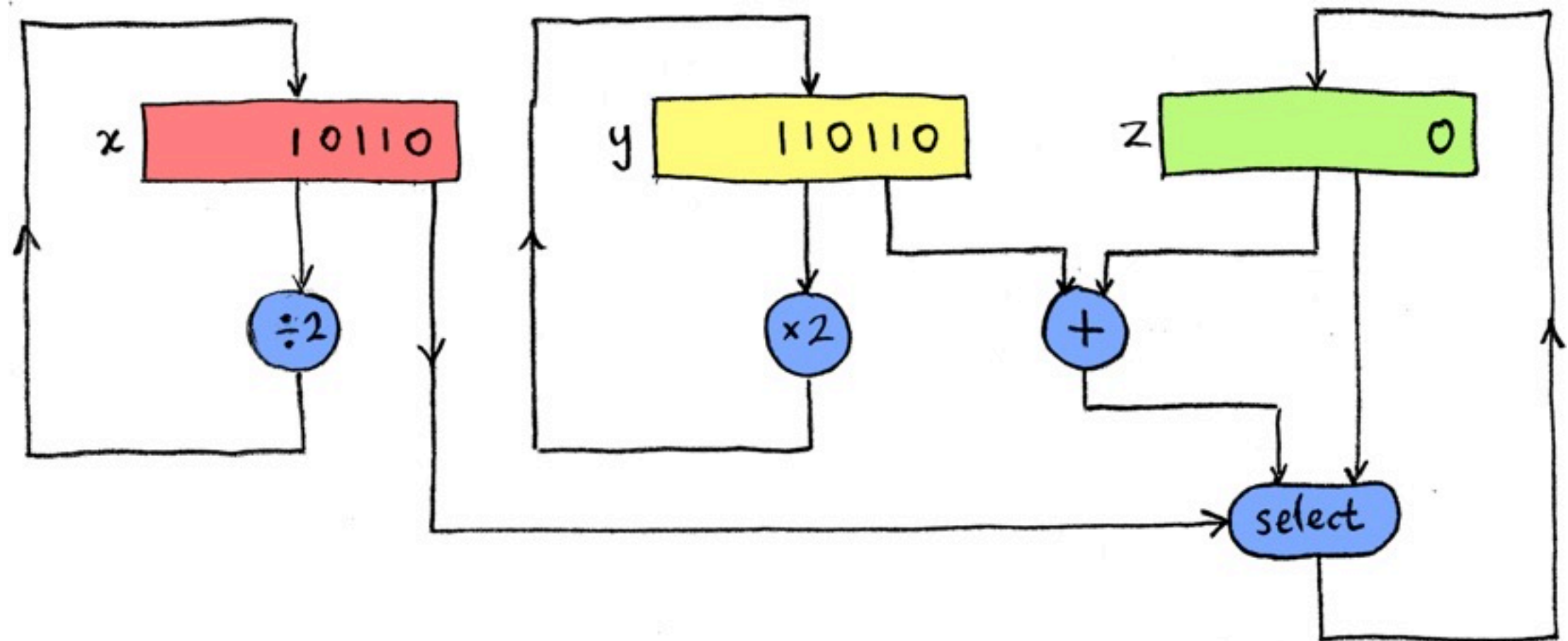


```
mul r0, r1, r2
```

return $a \times b$

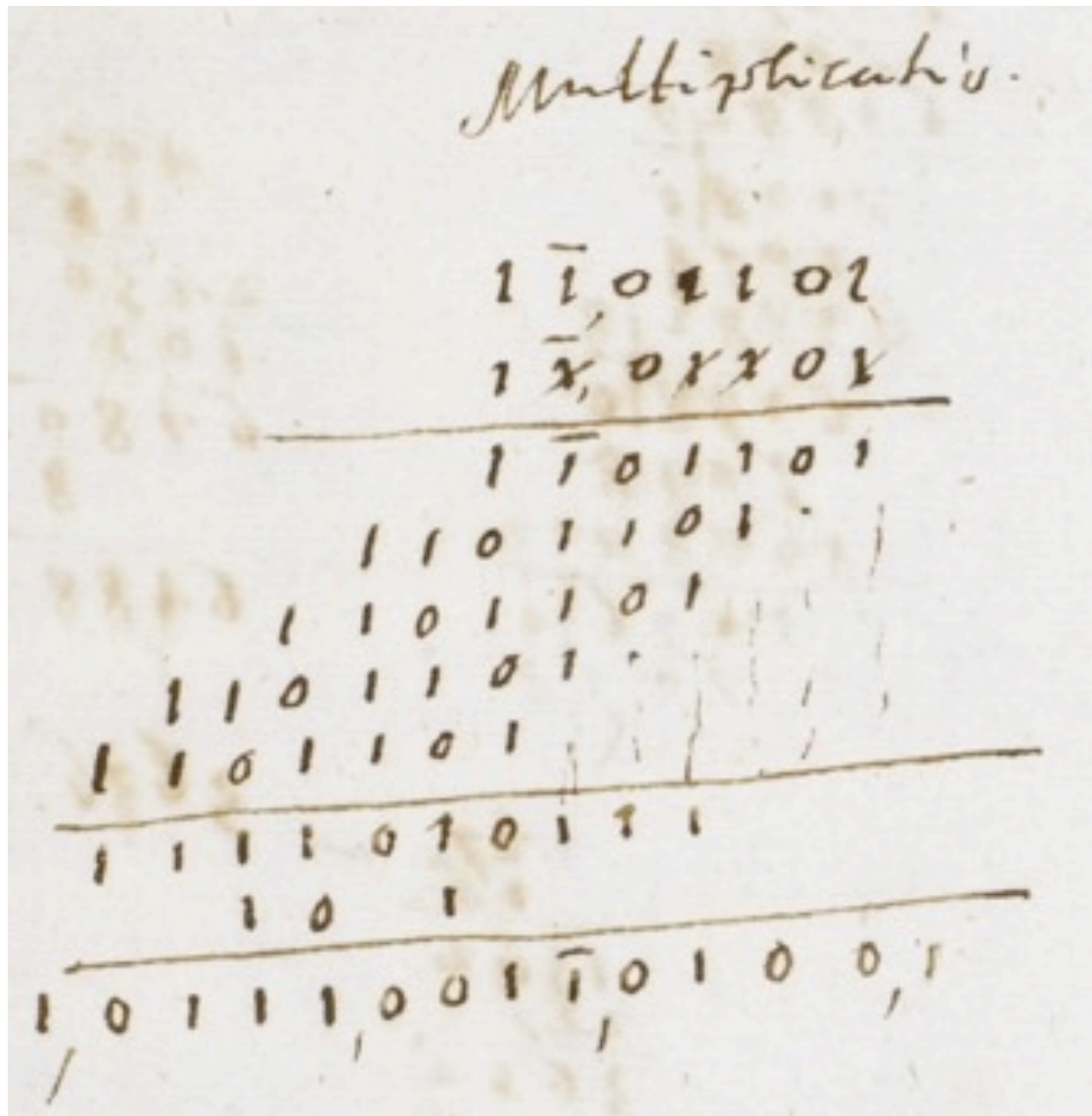
and have the multiplication done by an electronic circuit in the computer?

A multiplication circuit



A glimpse into history

Thomas Harriot (c.1560–1621):



Computer science

- It's *not* about learning new programming languages.
- It *is* about understanding why programs work, and how to design them.

In conclusion

- Computer programs (and computer hardware) are based on *algorithms* – fixed rules for calculating.
- If we want programs and computers to be reliable, we need to be able to explain why the answers are correct.
- Some computer systems do need to be totally reliable.

... and we need Maths for that.